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(54)【発明の名称】三次元光記録媒体用情報記録装置

(57)【要約】
【課題】　ホログラムとして情報が記録される三次元光記録媒体に情報を記録する情報記録装置であって、記録光のトラッキング及びフォーカシングを精度よく実現できる情報記録装置を提供する。
【解決手段】　記録領域を有し記録光を干渉させホログラムとして情報を記録する三次元光記録媒体と、前記光記録媒体にホログラムを記録するための前記記録光を出射する記録用光源と、前記光記録媒体に照射されこの媒体で反射されて、前記記録用光源と前記光記録媒体との相対的な位置調整のための位置調整光を出射する位置調整用光源と、前記記録用光源からの前記記録光を集光して前記光記録媒体に導く第１の集光手段と、前記位置調整用光源からの前記位置調整光を集光して前記光記録媒体に導く第２の集光手段と、前記光記録媒体で反射された前記位置調整光を検出して光強度を得る手段と、前記光強度に基づいて前記記録用光源と前記光記録媒体との相対的な位置を調整する手段とを具備する。

出射された前記記録光を集光する前記第１の集光手段と一体化されていることが好ましい。

【００１９】本発明の情報記録装置においては、位置調整用の光源から出射される位置調整光は、すでに光記録媒体に記録された干渉縞によって回折されることはない。したがって、記録光用光源と記録媒体との位置の調整を精度よく行なうことが可能である。

【００２０】

【発明の実施の形態】以下、本発明を詳細に説明する。

【００２１】本発明に係る記録装置でホログラムとして情報が記録される三次元光記録媒体は、光照射によって屈折率が変調する材料を少なくとも含有する記録層を有する。光照射などによって部分的に屈折率が変調する材料を記録層に備えていれば、いかなる原理を用いたものであっても構わない。

【００２２】例えば、光生成された電荷の再分布により生じた内部電場が屈折率を変調させるフォトリフラクティブ材料を記録層に備えるフォトリフラクティブ媒体、あるいは、光照射によって分子間または分子内の反応が生じて屈折率が変調するフォトポリマー材料を少なくとも記録層に備えるフォトポリマー媒体などが挙げられる。

【００２３】特に、フォトリフラクティブ媒体は、情報の消去が可能であるため望ましい。フォトリフラクティブ材料は光の透過率が高いため、記録層全体にホログラムを記録することができる。フォトリフラクティブ材料としては、上述したような特性を有するものであればいかなるものであってもよいが、例えば、C_{60}などのフラーレン、フタロシアニン化合物、アゾ化合物、ピラゾリン化合物あるいはナフタロシアニン化合物などを含有したものを用いることができる。

【００２４】さらに、記録層は、このような光照射により屈折率が変調する材料をポリススチレン、あるいはＰＭＭＡなどの透明高分子などからなるマトリックス材料中に分散してなることが望ましい。

【００２５】ただし、本発明の装置で記録再生が行なわれる三次元光記録媒体には、凹凸を有する反射層が形成されており、この反射層によって、記録光は反射されず、位置調整光のみが反射される。凹凸の幅は、通常１０００ｎｍ程度であり、その深さは、通常１５０ｎｍ程度である。

【００２６】次に、本発明に係る情報記録装置について説明する。

【００２７】図１に、本発明に係る三次元光記録媒体用情報記録装置の一例の構成を表わす概略図を示す。

【００２８】記録用光源（図示せず）から出射された光は、ビームスプリッター（図示せず）などの光を分割する手段により分割された後、図１（ａ）に示されるように、対物レンズ１１，１２により光記録媒体１６上の記録領域１３に集光される。記録する情報に対応して光の空間的な強度・位相を変調するために、空間変調器１０が一方の光路に配置されている。一方、位置調整用の光源（図示せず）から出射された光は、図１（ｂ）に示すように対物レンズ２１により光記録媒体１６上に集光され、記録光は透過するが位置調整光は反射する凹凸のある反射層により反射された後、再び対物レンズ２１を透過する。対物レンズ２１を透過した光は、トラッキング用光学系およびフォーカシング用光学系（図示せず）に送られ、トラッキング信号およびフォーカシング信号が得られる。

【００２９】トラッキング光学系としては、よく知られた非焦点法、フーコー法、またはスポットサイズ法などを用いることができる。一方、フォーカシング光学系としては、３ビーム法、プッシュプル法、あるいはウォブリング法などを用いることができる。

【００３０】ただし、位置調整用の光源から出射された位置調整光が集光される位置と、記録光が集光される位置との違いは既知であるとし、位置調整光のずれによって、記録光のずれがわかるとする。

【００３１】一方、記録された情報を再生するに当たっては、図１（ａ）に示すように、再生光１２を記録領域１３に照射して回折光を得て、これをレンズ１４により集光した後、ＣＣＤなどの分割検出器１５を用いて検出すればよい。対物レンズ１４は、次のように位置を調整しておく。すなわち、空間変調器１０および対物レンズ１１を経て光記録媒体１６を透過した光が対物レンズ１４を透過した後には、対物レンズ１１に入射する前の空間分布と相似な分布をもつ平行光となるように、対物レンズ１４の位置を調整する。

【００３２】なお、こうした構成の本発明の情報記録装置は、再生光を照射することによって、記録された情報を高いＳＮ比で再生することも可能である。

【００３３】本発明の情報記録装置においては、記録光は、三次元光記録媒体の反射層に形成された凹凸の溝に平行に、すなわちトラック方向に平行に入射されることが好ましい。

【００３４】この場合、トラック方向と垂直な方向（トラックの幅方向）に記録光による干渉縞が延びて、トラック方向に干渉縞が延びることはなくなる。したがって、かかる干渉縞による位置調整光は回折されるとしても、回折方向がトラック方向に沿った方向となる。このため、トラック方向に位置調整光がずれることとなり、位置調整はトラック方向での微調整を行なえば足りる。

【００３５】図２を参照して、反射層に形成された凹凸の溝の方向と記録光の照射方向との関係について説明する。図２（ａ）は、凹凸の溝と２つに分割された記録光との関係を示す鳥瞰図を表わし、図２（ｂ）は、凹凸の溝に垂直な方向の断面図を表わし、図２（ｃ）は、凹凸の溝に平行な方向の断面図を表わす。

【００３６】図２（ａ）に示されるように、三次元光記

録媒体（ディスク）１００の記録層１０４には、２つに分割された記録光１０１および１０２が照射される。これらの一方は、情報を付加された信号光であり、他方が参照光である。これら２つの光１０１および１０２が記録層内で交差することによって干渉縞１０７が形成されて、情報の記録が行なわれる。図２（ａ）に示されるように、媒体（ディスク）１００は、１０８の方向に回転しており、媒体１００の記録層１０４には、まず位置調整光１０６が照射され、その後、記録光１０１、１０２が照射される。これらの光照射の順番は、上述した順番が位置調整上好ましいが、逆の順番であってもよい。

【００３７】なお、信号光および参照光が照射される光記録媒体においては、図２（ｂ）および図２（ｃ）に示されるように、反射層１０５上に、記録層１０４および保護層１０３が順次形成されている。

【００３８】反射層１０５は、凹凸を表面に有する基板もしくは層でもよいが、凹凸を有する支持基板もしくは支持層上にかかる凹凸に沿って形成された膜とすることもできる。この場合にも、凹凸を有する反射層として機能する。かかる反射層の凹凸部は、凹部、凸部のいずれか一方からの反射光が強められる条件とする。凹部上の記録領域に記録が行なわれる場合には、凹部の反射光が強められるようにし、一方、凸部上の記録領域に記録が行なわれる場合には、凸部の反射光が強められるように設計する。

【００３９】トラックに沿った位置のぶれは、データを読み出すタイミングを調整することによって修正することができる。上述したようにトラックに垂直な方向のぶれをより小さくするために、トラックに垂直な方向に干渉縞１０７を記録して、トラックに垂直な方向の回折を小さくすることが好ましい。

【００４０】また、本発明の情報記録装置においては、位置調整用光源から照射される光の波長は、ホログラムを記録する前と後とで三次元光記録媒体の記録層の屈折率に実質的に変化がない波長であることが好ましい。かかる波長を選択することにより、媒体への記録を精度よく保持することが可能である。

【００４１】ここで、内部電場が生じたことによる三次元光記録媒体の吸収係数の変化（Δα）、および屈折率の変化（Δｎ）を、それぞれ波長の関数として図３のグラフに表わす。図３のグラフ中、曲線ａは吸収係数の変化（Δα）を表わし、曲線ｂは屈折率の変化（Δｎ）を示している。吸収係数の変化よりも屈折率の変化の方が、回折効率に大きく寄与するので、記録光としては波長λ_1付近の波長を用いることが好ましく、位置調整光としては、波長λ_2付近の波長を用いることが好ましい。

【００４２】なお、ホログラム記録前と記録後において、記録層の屈折率が実質的に変化しない波長は、例えば以下のようにして測定することができる。

【００４３】まず、対物レンズを用いて、水銀ランプからの白色光を屈折率変調領域近傍に集光する。このとき、スポットサイズはできるだけ小さいことが望まれる。また、白色光を照射することにより屈折率変調領域が消去されないように、白色光の強度を十分に小さくしておく。

【００４４】屈折率変調領域およびその近傍を透過した光を分光器に入射して波長選別し、その後、光電子倍増管を用いてその強度を波長の関数として測定する。得られた測定値と、記録前に同様にして測定したものとの比の常用対数をとることによって、記録前後の吸収スペクトルの差を測定することができる。さらに、Ｋｒａｍｅｒｓ－Ｋｒｏｎｉｇの関係より、吸収変化を波長の関数として表わしたものから屈折率変化を波長の関数として求めることができる。

【００４５】なお、光記録媒体におけるホログラムの記録前と記録後において、屈折率の変化しない波長λ_2は、光照射によって屈折率が変調する材料の種類のみならず、含有される材料の種類や量などによっても変動する。逆にいえば、それらの条件を制御して、波長λ_2を位置調整光の波長と同じくなるよう調整することも可能である。

【００４６】また、本発明の情報記録装置においては、記録用光源からの光は信号光と参照光との２つに分割され、これらの信号光および参照光は、それらの記録光によって記録された干渉縞によって位置調整光が一次の回折光を生じさせない入射角で三次元光記録媒体に入射されることが好ましい。これに関しては以下に詳細に説明するが、このような入射角で信号光と参照光との２つの光を入射することによって、ホログラムが記録されても位置調整光が回折を受けないようにすることができる。

【００４７】さらに、本発明の情報記録装置においては、位置調整用光源から出射された位置調整光を集光する第２の集光手段は、記録用光源から出射された光を集光する第１の集光手段と一体化されていることが好ましい。

【００４８】図４には、一体化された集光手段を有する情報記録装置の一例の構成を表わす概略図を示す。図示するように、記録光の光源１１０から出射された光は、記録光を分割する手段１１１により２つに分割される。その一方は、記録光を集光する手段１１４を経て、記録媒体（図示せず）に導かれる。分割された他方の光は、空間変調器１１２により空間的な強度・位相変調を与えた後、ミラー１１３、集光手段１１５を経て記録媒体（図示せず）に導かれる。

【００４９】位置調整用の光源１１６から照射された光ビームは、位置調整光を分割する手段１１７により分割され、１／４波長板１１８、集光手段１１９を経て、記録媒体へ導かれる。さらに、記録媒体の反射層で反射された光は、位置検出光学系（図示せず）へ導かれる。

【００５０】記録光を集光する手段１１４および１１５と、位置調整光を集光する手段１１９とは、図４において破線で囲んだように一体化されている。

【００５１】このように記録再生光を集光する手段と、位置調整光を集光する手段とが一体化した構成とすることによって、両者の相対的な位置が不変となるために、よりいっそう精度よく記録再生光の位置合わせを行なうことが可能となる。

【００５２】

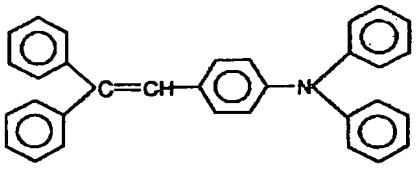
【発明の実施の形態】以下、実施例を示して本発明をさらに詳細に説明する。

【００５３】（光記録媒体の作製）まず、以下のようにして光記録媒体を作製した。

【００５４】フラーレン（C_{70}）、下記化学式（１）で表わされる化合物、下記化学式（２）で表わされる化合物、およびポリスチレンを、重量比が０．５：３０：１０：５９．５になるようにトルエンに溶解し、一昼夜冷暗所に放置した。

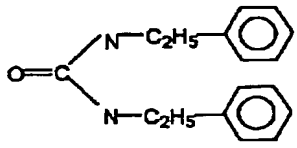
【００５５】

【化１】



【００５６】

【化２】



【００５７】一方、直径５ｃｍのガラス基板を用意し、その表面にＩＴＯ（ＩｎｄｉｕｍＴｉｎ　Ｏｘｉｄｅ）膜を形成し、裏面には凹凸を有する反射層を形成した。この反射層は、記録再生光を透過するが、位置調整光を反射する、例えばアルミニウムを用いて形成した。凹凸の寸法は、幅１０００ｎｍ、深さ１５０ｎｍとした。

【００５８】また、別途用意したガラス基板上にＩＴＯ膜を形成した。

【００５９】裏面に反射層が形成されたガラス基板のＩＴＯ膜上に、前述の放置後の溶液を塗布し、ヒーターを用いて背面からこのガラス基板を約８０℃で３時間加熱した。これにより、トルエンを蒸発させて記録層を形成した。

【００６０】さらに、透明基板を１４０℃に加熱して、厚さ１００μｍのスペーサーを載置して、前述のＩＴＯ膜付きガラス基板を対向配置した。この際、ＩＴＯ膜が記録層に接するようにガラス基板を配置した。この一対の透明基板全体に一様に圧力を加えて、記録層を一様に押し伸ばすことによって、厚さ１００μｍの記録層を形成した。

【００６１】さらに、分子の配向を行なうために、８０℃において透明基板間に１．２ｋＶの電圧を加えて１時間放置した。その後、３０分間電場を加えたまま試料を放置し、試料全体を室温まで冷却した。

【００６２】上述のようにして得られた光記録媒体の構成を表わす概略図を、図５に示す。図５（ａ）は、その平面図であり、凹凸のある反射層３１が形成されていることがわかる。また、図５（ｂ）はその断面図であり、ＩＴＯ膜３３が形成されたガラス基板３２と、ＩＴＯ膜３５が形成されたガラス基板３６との間には、スペーサー３４および３８とともに記録層３７が挟持されている。

【００６３】（情報記録装置の構成）図１を参照して、本実施例に係る光記録媒体の情報記録装置を説明する。

【００６４】光源（図示せず）から出射された光ビーム（記録光）は、ビームスプリッター（図示せず）などの光を分割する手段により分割された後、図１（ａ）に示されるように対物レンズ１１および１２に入射される。ビームスプリッターと対物レンズ１２との間には、光に空間的な強度変調を加えるための液晶からなる空間変調器１０が配置されている。対物レンズ１１と記録領域１３との距離は、対物レンズ１１の焦点距離と等しくし、対物レンズ１２と記録領域１３との距離は、対物レンズ１２の焦点距離の１．５倍とした。対物レンズ１１および１２は、集光された光の光軸が光記録媒体１６の記録層内で交差するように、その向きを調整する。また、対物レンズ１１を透過する光の光路長と、対物レンズ１２を透過する光の光路長との差は、光源のコヒーレント長より短い。

【００６５】対物レンズ１４は、対物レンズ１１で集光された後、光記録媒体１６を透過した光が、対物レンズ１１に入射した光と相似な強度・位相分布をもって出射されるように調整する。対物レンズ１４で平行光にされた光は、ＣＣＤカメラのような分割光検出器１５によって検出される。

【００６６】なお、光記録媒体１６は、駆動装置１７によって回転および三次元方向への平行移動が可能である。

【００６７】一方、位置調整用光源（図示せず）から出射された光は、図１（ｂ）に示すように、対物レンズ２１で集光された後、光記録媒体１６に垂直に照射される。光記録媒体１６には、予め動径方向の位置がわかるように溝が形成されているものとする。溝の表面には、記録再生光は透過するが、位置調整光は反射するようなヒューズドシリカ膜が形成されている。

【００６８】光記録媒体１６により反射された光は、再び対物レンズ２１を逆向きに透過した後、トラッキング

光学系およびフォーカシング光学系（図示せず）に送られる。トラッキングおよびフォーカシング光学系としては、任意のものを用いることができる。

【００６９】位置調整用の光源から出射された位置調整光が集光される焦点の位置と、記録再生光の焦点の位置との、三次元方向におけるずれは、予めわかっているものとする。また、位置調整用の光源からの位置調整光は、光記録媒体１６に常に照射されていてもよいし、断続的に照射されてもよいが、記録再生用の光源から出射され空間変調器１０を透過した光（信号光）は、記録時以外は光記録媒体１６に照射されないよう、遮られているものとする。

【００７０】（情報の記録）上述したように作製された光記録媒体に対し、本発明の情報記録装置を用いてムを記録した。

【００７１】まず、駆動装置１７を用いて、記録再生光の焦点が光記録媒体１６の記録領域１３の最も内側にくるようにする。この後に、位置調整用の光学系を用いて得られたトラッキング信号およびフォーカシング信号に基づいて、光記録媒体１６の位置を微調整する。

【００７２】記録したい情報に応じた透過光の強度分布が得られるよう空間変調器１０の状態を調整した後、記録光を所定の時間照射する。続いて、駆動装置１７を用いて光記録媒体１６を回転させて、異なる記録領域に記録光が照射されるようにする。その後、空間変調器１０の状態を次に記録したい情報に応じた状態に調節した後に、再び記録光を所定の時間照射する。

【００７３】このような手順を繰り返して、トラック方向に沿って、次々とデータを記録することができる。

【００７４】（情報の再生）次に、上記情報記録装置を用いて、光記録媒体に記録された情報の再生を行なう。

【００７５】まず、駆動装置１７を用いて、光記録媒体１６の記録層の最内周に対物レンズ１２の焦点がくるように調整する。位置調整用の光学系を用いて得られたトラッキング信号およびフォーカシング信号に基づいて、光記録媒体の位置を微調整する。次に、対物レンズ１２を透過する光を光記録媒体１６に照射して、トラック方向の位置を調整する。トラック方向の位置の調整は、文献“Ｉｍｐｌｅｍｅｎｔａｔｉｏｎ　ｏｆ　Ｈｏｌｏｇｒａｐｈｉｃ　Ｏｐｔｉｃａｌ　Ｄｉｓｃ”（Ｐｒｏｃｅｅｄｉｎｇ　ｏｆ　ｔｈｅ　Ｉｎｔｅｒｎａｔｉｏｎａｌ　Ｓｙｍｐｏｓｉｕｍ　ｏｎ　Ｏｐｔｉｃａｌ　Ｍｅｍｏｒｙ、ｐｐ１４～１５、１９９８）で行なわれているような手法によって、再生光が正しい位置に焦点を結んだことを確認することができる。具体的には、再生光を照射した際に情報が再生される領域の外に窓を設けておき、この窓にピットが到達したときに、再生光が正しい位置に焦点を結んだことになる。再生光が回折されたものをＣＤなどの分割された光検出器１５により測定することによって、高いＳＮ比で情報を再生することができる。

【００７６】特に、図２を参照してすでに説明したように、対物レンズ１１、１２で集光された光の光軸がトラック方向に平行である場合には、精度よく記録再生光の位置合わせができる。

【００７７】また、図３を参照して説明したように、位置調整光の波長がホログラム記録前と記録後で光記録媒体の屈折率が変化しない波長であるとき、精度よく記録再生光の位置合わせができる。

【００７８】さらに、本発明の情報記録装置においては、記録用光源からの光は信号光と参照光との２つに分割され、これらの信号光および参照光は、一次干渉を生じさせない入射角で三次元光記録媒体に入射されることが好ましい。具体的には、対物レンズ１１および１２の中心と記録領域１３の中心とを結んだ線が三次元光記録媒体１６の表面となす角をそれぞれθ1、θ2とした場合に、以下に説明する条件を満たすことが好ましい。この条件が満たされると、トラッキング信号およびフォーカシング信号を得る際のノイズを、よりいっそう小さくすることが可能である。

【００７９】ただし、記録層の屈折率をｎ、記録再生用の光源および位置調整用の光源から出射される光の波長を、それぞれλ_1およびλ_2とする。図６を参照して、これに関して説明する。

【００８０】ホログラム記録のときには、レーザー光を集光して光記録媒体に照射するが、簡単のために、光軸を通る平行光が照射されるとして、ホログラムが記録されても位置調整光が回折を受けない条件を以下に求める。

【００８１】記録用光源からの光は、信号光と参照光との２つに分割され、これら２つの光を三次元光記録媒体に照射して内部で交差させることによって、干渉縞が形成される。ここで、光記録媒体の外側で測定した信号光の入射角がθ1のとき、光記録媒体内部で測定した入射角$\theta 1^{in}$は、$n \sin\theta 1^{in} = \sin\theta 1$より求められる。同様に参照光に対しても、$n \sin\theta 2^{in} = \sin\theta 2$から、記録媒体内部で測定した入射角が求められる。このとき、形成される干渉縞の波数ベクトルは、下記数式（１）で求められる。

【００８２】

【数１】

$$\vec{k} = \overrightarrow{k_1} - \overrightarrow{k_2} = \frac{2\pi}{\lambda 1/n}\begin{pmatrix} \sin\theta 1^{in} - \sin\theta 2^{in} \\ 0 \\ \cos\theta 1^{in} - \cos\theta 2^{in} \end{pmatrix}$$

【００８３】このような干渉縞に、垂直に位置調整光が照射されたとき、最も強く回折が生じるのは、下記数式（２）を満たすθ0が存在するときである。

【００８４】

【数２】

$$\frac{\Lambda}{\sin\theta K}+\frac{\Lambda}{\sin\theta 0}=\lambda 2/n$$

【００８５】したがって、位置調整光が強く回折される方向が存在しない条件は、下記数式（３）で表わされる。

【００８６】

【数３】

$$\frac{1}{\sin\theta 0}=\frac{\lambda 2/n}{\Lambda}-\frac{1}{\sin\theta K}$$

$$=\left(\frac{\lambda 2}{\lambda 1}-\frac{1}{\cos\theta 2^{in}-\cos\theta 1^{in}}\right)^{*}\sqrt{2-2\cos\left(\theta 2^{in}-\theta 1^{in}\right)}<1$$

【００８７】このような条件を満たすことによって、ホログラムが記録されても位置調整光は干渉を受けないので、トラッキング信号およびフォーカシング信号を得る際のノイズをよりいっそう低減することが可能となる。

【００８８】なお、本発明は上述した実施形態に限定されるものではない。例えば、位置調整光が媒体中を透過するようにして透過光を検出することによって位置調整を行なってもよい。その他、本発明の趣旨を逸脱しない範囲で種々変形して実施可能である。

【００８９】

【発明の効果】以上詳述したように本発明によれば、ホログラムとして情報が記録される三次元光記録媒体に情報を記録する情報記録装置であって、記録光のトラッキングおよびフォーカシングを精度よく実現できる情報記録装置が提供される。本発明の情報記録装置を用いることによって、三次元記録媒体のデータ再生のＳＮ比を著しく向上することができ、その工業的価値は絶大である。

【図面の簡単な説明】

【図１】本発明に係る情報記録装置の一例の構成を表わす概略図。

【図２】反射層に形成された凹凸の溝の方向と記録光の照射方向との関係を説明する概略図。

【図３】光記録媒体の吸収係数および屈折率の変化を波長の関数として表わしたグラフ図。

【図４】本発明に係る情報記録装置の他の例の構成を表わす概略図。

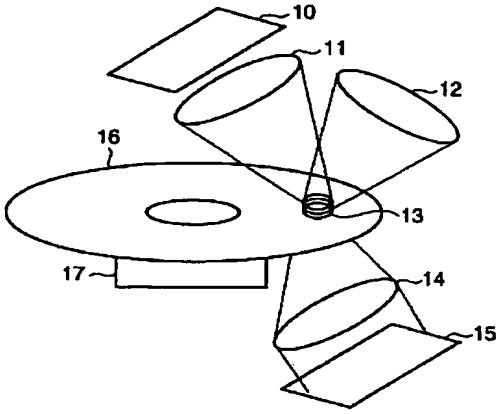
【図５】実施例で作製された三次元光記録媒体の構成を表わす概略図。

【図６】信号光と参照光とによって形成される干渉縞を説明する概略図。

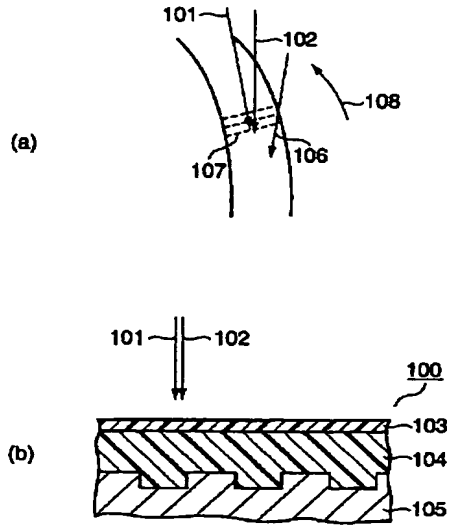
【符号の説明】

１０…空間変調器
１１，１２…集光手段（レンズ）
１３…ホログラム記録領域
１４…対物レンズ
１５…検出器
１６…三次元光記録媒体
１７…駆動装置
２１…集光手段（レンズ）
３１…凹凸のある反射膜
３２…ガラス基板
３３…ＩＴＯ膜
３４…スペーサー
３５…ＩＴＯ膜
３６…ガラス基板
３７…記録層
３８…スペーサー
１００…三次元光記録媒体（ディスク）
１０１…信号光
１０２…参照光
１０３…保護層
１０４…記録層
１０５…反射層
１０６…位置調整光
１０７…干渉縞
１０８…媒体の回転方向
１１０…記録光の光源
１１１…記録光を分割する手段
１１２…記録光に空間的な強度・位相変調を与える手段
１１３…ミラー
１１４，１１５…記録光を集光する手段
１１６…位置調整光の光源
１１７…位置調整光を分割する手段
１１８…１／４波長板
１１９…位置調整光を集光する手段

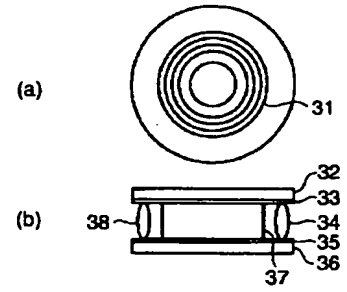
【図１】



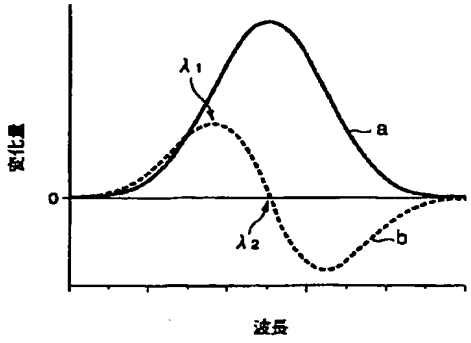
【図２】



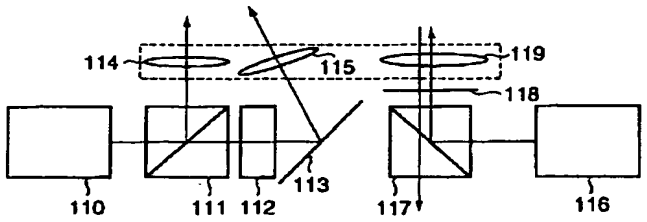
【図５】



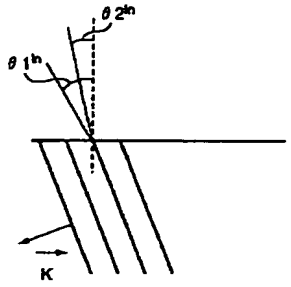
【図３】



【図４】



【図６】



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(54) INFORMATION RECORDING DEVICE FOR THREE-DIMENSIONAL OPTICAL RECORDING MEDIUM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an information recording device that records information on a three-dimensional optical recording medium that records information as a hologram and can realize the tracking and focusing of recording light with good precision.

SOLUTION: The device is provided with a three-dimensional optical recording medium having a recording area, interfering in the recording light and recording information as the hologram, a light source for recording that emits the recording light to record the hologram on the optical recording medium, a light source for adjusting a position that irradiates the optical recording medium, reflects this medium, and emits position adjusting light for adjusting position relative to the light source for recording and the optical recording medium, a first collection means that condenses the recording light from the light source for recording and leads it to the optical recording medium, a second collection means that condenses the position adjusting light from the light source for adjusting the position and leads it to the optical recording medium, a means that detects the position adjusting light reflected in the optical recording medium and obtains optical power, and a means adjusting a position relative to the light source for recording and the optical recording medium based on the optical power.

LEGAL STATUS

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[Date of extinction of right]	

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The Motomitsu Mitsugi record medium which have a record section, and record light is made to interfere, and records information on said record section in three dimensions as a hologram, The light source for record which carries out outgoing radiation of said record light for recording a hologram on said Motomitsu Mitsugi record medium, The light source for justification which carries out outgoing radiation of the justification light which said Motomitsu Mitsugi record medium irradiates, is reflected by this medium, and is used for relative justification with said light source for record, and said Motomitsu Mitsugi record medium, The 1st condensing means which condenses said record light by which outgoing radiation was carried out from said light source for record, and is led to said Motomitsu Mitsugi record medium, The 2nd condensing means which condenses said justification light by which outgoing radiation was carried out from said light source for justification, and is led to said Motomitsu Mitsugi record medium, The information recording device for Motomitsu Mitsugi record media characterized by providing a means to detect said justification light reflected with said Motomitsu Mitsugi record medium, and to obtain optical reinforcement, and a means to adjust the relative location of said light source for record, and said Motomitsu Mitsugi record medium based on said obtained optical reinforcement.
[Claim 2] The information recording device for Motomitsu Mitsugi record media according to claim 1 characterized by forming the reflecting layer which has irregularity in said record section of said Motomitsu Mitsugi record medium according to the truck of said record section, and reflects said justification light in it on the front face of this irregularity.
[Claim 3] Said record light from said light source for record is an information recording device for Motomitsu Mitsugi record media according to claim 2 characterized by carrying out incidence to said Motomitsu Mitsugi record medium in parallel with the slot of the irregularity of said reflecting layer of said Motomitsu Mitsugi record medium.
[Claim 4] Record of the information in said Motomitsu Mitsugi record medium The wavelength of said justification light by which is performed by change of the refractive index of said record section of said Motomitsu Mitsugi record medium, and outgoing radiation is carried out from said light source for justification The information recording device for Motomitsu Mitsugi record media given in claim 1 characterized by being the wavelength which does not have change in the refractive index of said record section of said Motomitsu Mitsugi record medium substantially in the back before recording a hologram thru/or any 1 term of 3.
[Claim 5] It is an information recording device for Motomitsu Mitsugi record media given in claim 1 which said record light by which outgoing radiation was carried out from said light source for record is divided into two, signal light and a reference beam, and is characterized by carrying out incidence of said signal light and said reference beam to said Motomitsu Mitsugi record medium by the incident angle which does not produce primary interference of said justification light thru/or any 1 term of 4.
[Claim 6] Said 2nd condensing means to condense said justification light by which outgoing radiation was carried out from said light source for justification is an information recording device for Motomitsu

Mitsugi record media given in claim 1 characterized by uniting with said 1st condensing means to condense said record light by which outgoing radiation was carried out from said light source for record thru/or any 1 term of 5.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the information recording device which records information on a Motomitsu Mitsugi record medium, and relates to the recording device which records information on holographic memory especially.
[0002]
[Description of the Prior Art] It considers as the medium which can record data with a big capacity, such as a high density image, and the optical recording medium is known. Although the magneto-optic-recording medium, the optical phase change mold medium, etc. are conventionally developed as an optical recording medium, the demand to the densification of amount of information recordable on an optical recording medium is increasing steadily.
[0003] In order to realize densification of the amount of information recorded on an optical recording medium, the Motomitsu Mitsugi record medium is proposed. In this Motomitsu Mitsugi record medium, the signal light to which two or more information was added as spatial distribution of optical reinforcement, and the light called a reference beam are irradiated at coincidence at a sample, and information is recorded on an optical recording medium as a hologram.
[0004] In the case of the conventional optical phase change mold medium which was mentioned above, since light was condensed with an objective lens and 1 bit of information was recorded at a time on the beam spot, storage capacity was restricted by the beam diameter. On the other hand, in the holographic record using a photochromic ingredient or a photograph RIKURAKUTIBU ingredient, information is recorded on a record medium as a hologram by making signal light, this, and a coherent reference beam cross in a record medium. At this time, reinforcement and phase contrast correspond to information.
[in / in the light which has spatial distribution in reinforcement or a phase as a signal light / ****** and a specific field] Therefore, two or more information which spread in the direction of two dimension is recordable as one hologram.
[0005] It is possible to record a hologram which is different to the overlapping field by changing the include angle of signal light or a reference beam, or changing slightly the location where light is irradiated in holographic record. For this reason, in holographic record, it is said that far big storage capacity is realizable compared with an old recording method.
[0006] In this way, what is necessary is just to carry out incidence of the read-out light to the same location at the same include angle as a reference beam, in order to reproduce the information recorded on the optical recording medium in the form of a hologram. Consequently, since signal light is reproduced by the principle of a hologram, the reproduced signal luminous-intensity distribution is detectable with division detectors, such as CCD.
[0007] However, in order to reproduce a hologram, it must read in the completely same condition as the reference beam at the time of record, and incidence of the light must be carried out. For this reason, the tracking and focusing for irradiating the light beam irradiated from the light source for record playback in the same location on a record medium are needed. In order to attain this conventionally, the following

two methods are learned.
[0008] a one-eyed approach -- reference "Implementation of Holographic Optical Disc", G.Zhou, A.Pu, O.Ivanova, and F. -- Mok and and D.Psaltis and Proceedingof the International Symposium on Optical It is stated to Memory (15 pp14- 1998). This approach is the approach of recording the signal for justification on the outside of a data area. That is, by calculating the reinforcement of the signal for justification detected with a division detector, when playback light is irradiated, while determining the timing which incorporates data, tracking is performed. However, since the optical reinforcement of the hologram generally reproduced becomes weak as it separates from an optical axis, a large SN ratio cannot be taken by this approach.
[0009] In another approach, the optical recording medium which has an irregular reflector is used. The same tracking and same focusing as the case where the usual optical disks, such as CD (compact disk) and DVD (digital bar SAITARU disk), are used are performed by forming an address field and a data storage area and irradiating light to an address field. These justification approaches are explained to reference "an optical pickup head", ditch Yoshikazu, the Kato sincerity, Journal of Applied Physics, the December, Heisei 11 issue, and pp.1401-1406 at the detail. However, unlike DVD whose thickness of a recording layer is several nm, in the case of a hologram, the thickness of a recording layer is as large as about 1mm. In the case of such a hologram, even if it records a hologram centering on a data area, the problem that the hologram recorded when the light for justification was irradiated to an address field diffracts arises.
[0010] By the justification approach used with CD or DVD, a tracking signal and a focusing signal are acquired based on the breadth condition of light reflected in the reflector established in the optical recording medium. Therefore, it will become a noise if the light for justification is diffracted by the hologram. In the place which raised diffraction efficiency in order to raise the SN ratio of data playback, diffraction will happen greatly also at the time of justification. Therefore, the precision of justification falls and the SN ratio of data playback does not become large after all, either.
[0011]
[Problem(s) to be Solved by the Invention] As mentioned above, since a recording layer is several nm, even if recording layers are any of a crystallized state or an amorphous condition, by the current optical phase change medium, the diffraction of light and dispersion in a recording layer seldom become a problem. However, since a recording layer is as thick as about 1mm in the record medium used for holographic memory, if a hologram is recorded on a recording layer, in this recording layer, not only playback light but justification light will be diffracted. As for such a phenomenon, for a justification signal, since it becomes a noise, tracking with a high precision becomes impossible. If it is going to enlarge diffraction efficiency in order to raise the SN ratio of informational playback, since the light for justification will be diffracted similarly, the noise contained in a justification signal becomes still larger. After all, there was a trouble that the SN ratio of data playback could not be improved.
[0012] Then, this invention is an information recording device which records information on the Motomitsu Mitsugi record medium with which information is recorded as a hologram, and aims at offering the information recording device which can realize the tracking and focusing of record light with a sufficient precision.
[0013]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, this invention has a record section and is made to interfere in record light. As a hologram The Motomitsu Mitsugi record medium which records information on said record section in three dimensions, and the light source for record which carries out outgoing radiation of said record light for recording a hologram on said Motomitsu Mitsugi record medium, The light source for justification which carries out outgoing radiation of the justification light which said Motomitsu Mitsugi record medium irradiates, is reflected by this medium, and is used for relative justification with said light source for record, and said Motomitsu Mitsugi record medium, The 1st condensing means which condenses said record light by which outgoing radiation was carried out from said light source for record, and is led to said Motomitsu Mitsugi record medium, The 2nd condensing means which condenses said justification light by which

outgoing radiation was carried out from said light source for justification, and is led to said Motomitsu Mitsugi record medium, A means to detect said justification light reflected with said Motomitsu Mitsugi record medium, and to obtain optical reinforcement, The information recording device for Motomitsu Mitsugi record media characterized by providing a means to adjust the relative location of said light source for record and said Motomitsu Mitsugi record medium, based on said obtained optical reinforcement is offered.

[0014] It is desirable that the reflecting layer which has irregularity in said record section of said Motomitsu Mitsugi record medium according to the truck of said record section, and reflects said justification light in it on the front face of this irregularity is formed.

[0015] As for said record light from said light source for record, in the information recording device of this invention, it is desirable that incidence is carried out to said Motomitsu Mitsugi record medium in parallel with the slot of the irregularity of said reflecting layer of said Motomitsu Mitsugi record medium.

[0016] Moreover, as for the wavelength of said justification light by which record of the information in said Motomitsu Mitsugi record medium is performed by change of the refractive index of said record section of said Motomitsu Mitsugi record medium, and outgoing radiation is carried out from said light source for justification, in the information recording device of this invention, it is desirable that it is the wavelength which does not have change in the refractive index of said record section of said Motomitsu Mitsugi record medium substantially in the back before recording a hologram.

[0017] Said record light by which outgoing radiation was carried out from said light source for record in the information recording device of this invention is divided into two, signal light and a reference beam, and, as for said signal light and said reference beam, it is still more desirable that incidence is carried out to said Motomitsu Mitsugi record medium by the incident angle which does not produce primary interference of said justification light.

[0018] Furthermore, as for said 2nd condensing means to condense said justification light by which outgoing radiation was carried out from said light source for justification, in the information recording device of this invention, it is desirable to unite with said 1st condensing means to condense said record light by which outgoing radiation was carried out from said light source for record.

[0019] In the information recording device of this invention, the justification light by which outgoing radiation is carried out from the light source for justification is not diffracted by the interference fringe already recorded on the optical recording medium. Therefore, it is possible to adjust the location of the light source for record light and a record medium with a sufficient precision.

[0020]

[Embodiment of the Invention] Hereafter, this invention is explained to a detail.

[0021] The Motomitsu Mitsugi record medium on which information is recorded as a hologram with the recording device concerning this invention has the recording layer which contains at least the ingredient which a refractive index modulates by optical exposure. As long as it equips the recording layer with the ingredient which a refractive index modulates partially by optical exposure etc., what kind of principle may be used.

[0022] For example, the photorefractive medium by which the internal electric field produced by the redistribution of the charge by which optical generation was carried out equip a recording layer with the photorefractive ingredient which modulates a refractive index, or the photopolymer medium which equips a recording layer with the photopolymer ingredient which the reaction of between molecules or intramolecular produces and a refractive index modulates by optical exposure at least is mentioned.

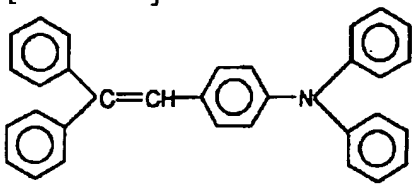
[0023] Since informational elimination is possible for especially a photorefractive medium, it is desirable. Since a photorefractive ingredient has the high permeability of light, it can record a hologram on the whole recording layer. Although you may be what kind of thing as long as it has a property which was mentioned above as a photorefractive ingredient, the thing containing fullerene, a phthalocyanine compound, an azo compound, a pyrazoline compound, or naphthalocyanine compounds, such as C60, etc. can be used, for example.

[0024] Furthermore, as for a recording layer, it is desirable to come to distribute the ingredient which a

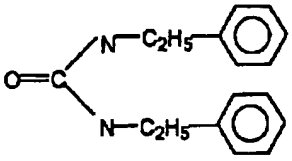
refractive index modulates by such optical exposure in the matrix material which consists of transparence macromolecules, such as police styrene or PMMA, etc.
[0025] However, the reflecting layer which has irregularity is formed in the Motomitsu Mitsugi record medium to which record playback is performed with the equipment of this invention, record light is not reflected by this reflecting layer, but only justification light is reflected. Concavo-convex width of face is usually about 1000nm, and the depth is usually about 150nm.
[0026] Next, the information recording device concerning this invention is explained.
[0027] The schematic diagram which expresses the configuration of an example of the information recording device for Motomitsu Mitsugi record media concerning this invention to drawing 1 is shown.
[0028] After the light by which outgoing radiation was carried out from the light source for record (not shown) is divided by means to divide light, such as a beam splitter (not shown), as shown in drawing 1 (a), it is condensed with objective lenses 11 and 12 by the record section 13 on an optical recording medium 16. In order to modulate spatial reinforcement and phase of light corresponding to the information to record, the space modulator 10 is arranged at one optical path. On the other hand, the light by which outgoing radiation was carried out from the light source for justification (not shown) is condensed on an optical recording medium 16 with an objective lens 21, as shown in drawing 1 (b), and although record light penetrates, justification light penetrates an objective lens 21 again, after being reflected by the reflecting layer with the irregularity to reflect. The light which penetrated the objective lens 21 is sent to the optical system for tracking, and the optical system for focusing (not shown), and a tracking signal and a focusing signal are acquired.
[0029] the non-focal method well known as tracking optical system, and Foucault -- law or the spot-size method can be used. On the other hand, as focusing optical system, the 3 beam method, the push bull method, or the wobbling method can be used.
[0030] However, the difference between the location where the justification light by which outgoing radiation was carried out from the light source for justification is condensed, and the location where record light is condensed presupposes that it is known, and presupposes that a gap of justification light shows a gap of record light.
[0031] What is necessary is on the other hand, in reproducing the recorded information, to irradiate the playback light 12 in a record section 13, to obtain the diffracted light, and just to detect this using the division detectors 15, such as CCD, after condensing with a lens 14 as shown in drawing 1 (a). The objective lens 14 adjusts the location as follows. That is, after the light which penetrated the optical recording medium 16 through the space modulator 10 and the objective lens 11 penetrates an objective lens 14, the location of an objective lens 14 is adjusted so that it may become parallel light with distribution [**** / the spatial distribution before carrying out incidence to an objective lens 11].
[0032] In addition, the information recording device of this invention of such a configuration can also reproduce the recorded information with a high SN ratio by irradiating playback light.
[0033] As for record light, in the information recording device of this invention, it is desirable that incidence is carried out in parallel with the direction of a truck in parallel with the slot of the irregularity formed in the reflecting layer of a Motomitsu Mitsugi record medium.
[0034] In this case, it is lost that the interference fringe by record light is prolonged in the direction (cross direction of a truck) perpendicular to the direction of a truck, and an interference fringe is prolonged in the direction of a truck. Therefore, though the justification light by this interference fringe is diffracted, the diffraction direction turns into a direction which met in the direction of a truck. For this reason, justification light will shift in the direction of a truck, and it is sufficient if justification performs fine tuning in the direction of a truck.
[0035] With reference to drawing 2 , the relation of the direction of the slot on concavo-convex and the direction of radiation of record light which were formed in the reflecting layer is explained. Drawing 2 (a) expresses the bird's-eye view showing the relation between the slot on concavo-convex, and the record light divided into two, drawing 2 (b) expresses the sectional view of a direction perpendicular to the slot on concavo-convex, and drawing 2 (c) expresses the sectional view of a direction parallel to the slot on concavo-convex.

[0036] As shown in drawing 2 (a), the record light 101 and 102 divided into two is irradiated by the recording layer 104 of the Motomitsu Mitsugi record medium (disk) 100. These one side is the signal light to which information was added, and another side is a reference beam. When these two light 101 and 102 crosses within a recording layer, an interference fringe 107 is formed and informational record is performed. As shown in drawing 2 (a), the medium (disk) 100 is rotating in the direction of 108, the justification light 106 is first irradiated by the recording layer 104 of a medium 100, and the record light 101 and 102 is irradiated after that. Although the sequence of these optical exposures has on justification the desirable sequence mentioned above, it may be reverse sequence.
[0037] In addition, in the optical recording medium with which signal light and a reference beam are irradiated, as shown in drawing 2 (b) and drawing 2 (c), sequential formation of a recording layer 104 and the protective layer 103 is carried out on the reflecting layer 105.
[0038] Although the substrate or layer which has irregularity on a front face is sufficient as a reflecting layer 105, it can also be used as the film formed along with the irregularity applied on the support substrate or supporters who has irregularity. Also in this case, it functions as a reflecting layer which has irregularity. The concave heights of this reflecting layer are taken as the conditions by which the reflected light from a crevice or heights is strengthened. When record is performed to the record section on a crevice, the reflected light of a crevice is strengthened, and on the other hand, when record is performed to the record section on heights, it designs so that the reflected light of heights may be strengthened.
[0039] Blurring of a location along a truck is correctable by adjusting the timing which reads data. As mentioned above, in order to make blurring of a direction perpendicular to a truck smaller, it is desirable to record an interference fringe 107 in the direction perpendicular to a truck, and to make diffraction of a direction perpendicular to a truck small.
[0040] Moreover, as for the wavelength of the light irradiated from the light source for justification, in the information recording device of this invention, it is desirable that it is the wavelength which does not have change in the refractive index of the recording layer of a Motomitsu Mitsugi record medium substantially in the back before recording a hologram. By choosing this wavelength, it is possible to hold record to a medium with a sufficient precision.
[0041] Here, change (deltaalpha) of the absorption coefficient of the Motomitsu Mitsugi record medium by internal electric field having been generated and change (deltan) of a refractive index are expressed with the graph of drawing 3 as a function of wavelength, respectively. Among the graph of drawing 3 , Curve a expresses change (deltaalpha) of an absorption coefficient, and Curve b shows change (deltan) of a refractive index. It is desirable that it uses the wavelength of the wavelength lambda1 neighborhood as a record light since the direction of change [change / of an absorption coefficient] of a refractive index contributes to diffraction efficiency greatly, and it is desirable as a justification light to use the wavelength of the wavelength lambda2 neighborhood.
[0042] In addition, the wavelength from which the refractive index of a recording layer does not change substantially a hologram record front and after record is the following, and can be made and measured.
[0043] First, the white light from a mercury lamp is condensed near the refractive-index modulation field using an objective lens. At this time, it is desired for spot size to be small as much as possible. Moreover, by irradiating the white light, reinforcement of the white light is made small enough so that a refractive-index modulation field may not be eliminated.
[0044] Incidence of the light which penetrated a refractive-index modulation field and its near is carried out to a spectroscope, wavelength sorting is carried out and the reinforcement is measured as a function of wavelength after that using a photo multiplier. The difference of the absorption spectrum before and behind record can be measured by taking the common logarithm of the ratio of the obtained measured value and the thing measured similarly before record. Furthermore, it can ask for refractive-index change as a function of wavelength from the relation of Kramers-Kronig from what expressed absorption change as a function of wavelength.
[0045] In addition, the wavelength lambda 2 from which a refractive index does not change the record front of the hologram in an optical recording medium and after record is changed not only with the class

of ingredient which a refractive index modulates by optical exposure but with a class, an amount, etc. of an ingredient to contain. Conversely, if it says, it is also possible to control those conditions, and to adjust wavelength lambda 2 so that it may become the same with the wavelength of justification light.
[0046] Moreover, in the information recording device of this invention, the light from the light source for record is divided into two, signal light and a reference beam, and, as for these signal light and reference beams, it is desirable that incidence is carried out to a Motomitsu Mitsugi record medium by the incident angle which justification light does not make produce the primary diffracted light by the interference fringe recorded by those record light. Even if a hologram is recorded, justification light can be prevented from receiving diffraction by carrying out incidence of the two light of signal light and a reference beam by such incident angle, although this is explained below at a detail.
[0047] Furthermore, as for the 2nd condensing means which condenses the justification light by which outgoing radiation was carried out from the light source for justification, in the information recording device of this invention, it is desirable to unite with the 1st condensing means which condenses the light by which outgoing radiation was carried out from the light source for record.
[0048] The schematic diagram which expresses the configuration of an example of an information recording device which has the unified condensing means to drawing 4 is shown. The light by which outgoing radiation was carried out from the light source 110 of record light is divided into two by means 111 to divide record light so that it may illustrate. One of these is led to a record medium (not shown) through a means 114 to condense record light. After the light of divided another side gives spatial reinforcement and phase modulation with the space modulator 112, it is led to a record medium (not shown) through a mirror 113 and the condensing means 115.
[0049] The light beam irradiated from the light source 116 for justification is divided by means 117 to divide justification light, and is led to a record medium through the quarter-wave length plate 118 and the condensing means 119. Furthermore, the light reflected by the reflecting layer of a record medium is led to location detection optical system (not shown).
[0050] Means 114 and 115 to condense record light, and a means 119 to condense justification light are unified as surrounded with the broken line in drawing 4 .
[0051] Thus, since both relative location becomes eternal by considering as the configuration which a means to condense record playback light, and a means to condense justification light unified, it becomes possible to perform alignment of record playback light with a much more sufficient precision.
[0052]
[Embodiment of the Invention] Hereafter, an example is shown and this invention is further explained to a detail.
[0053] (Production of an optical recording medium) First, as it was the following, the optical recording medium was produced.
[0054] It dissolved in toluene so that a weight ratio might be set to 0.5:30:10:59.5, and fullerene (C70), the compound expressed with the following chemical formula (1), the compound expressed with the following chemical formula (2), and polystyrene were left in the cool place one whole day and night.
[0055]
[Formula 1]



[0056]
[Formula 2]



[0057] On the other hand, the glass substrate with a diameter of 5cm was prepared, the ITO (IndiumTin Oxide) film was formed in the front face, and the reflecting layer which has irregularity was formed in the rear face. Although this reflecting layer penetrated record playback light, it reflects justification light, for example, formed it using aluminum. The concavo-convex dimension was made into width of face of 1000nm, and a depth of 150nm.
[0058] Moreover, the ITO film was formed on the glass substrate prepared separately.
[0059] The solution after the above-mentioned neglect was applied on the ITO film of the glass substrate with which the reflecting layer was formed in the rear face, and this glass substrate was heated at about 80 degrees C from the tooth back for 3 hours using the heater. Thereby, toluene was evaporated and the recording layer was formed.
[0060] Furthermore, the transparence substrate was heated at 140 degrees C, the spacer with a thickness of 100 micrometers was laid, and opposite arrangement of the above-mentioned glass substrate with the ITO film was carried out. Under the present circumstances, the glass substrate has been arranged so that the ITO film may touch a recording layer. The recording layer with a thickness of 100 micrometers was formed by applying a pressure to the whole transparence substrate of this pair uniformly, pushing a recording layer uniformly and lengthening it.
[0061] Furthermore, in order to perform orientation of a molecule, in 80 degrees C, the electrical potential difference of 1.2kV was applied between transparence substrates, and it was left for 1 hour. Then, the sample was left adding electric field for 30 minutes, and the whole sample was cooled to the room temperature.
[0062] The schematic diagram showing the configuration of the optical recording medium obtained as mentioned above is shown in drawing 5 . It is the top view and, as for drawing 5 (a), it turns out that the irregular reflecting layer 31 is formed. Moreover, drawing 5 (b) is the sectional view, and the recording layer 37 is pinched with spacers 34 and 38 between the glass substrate 32 with which the ITO film 33 was formed, and the glass substrate 36 with which the ITO film 35 was formed.
[0063] (Configuration of an information recording device) With reference to drawing 1 , the information recording device of the optical recording medium concerning this example is explained.
[0064] After the light beam (record light) by which outgoing radiation was carried out from the light source (not shown) is divided by means to divide light, such as a beam splitter (not shown), as shown in drawing 1 (a), incidence of it is carried out to objective lenses 11 and 12. Between the beam splitter and the objective lens 12, the space modulator 10 which becomes light from the liquid crystal for adding spatial intensity modulation is arranged. Distance of an objective lens 11 and a record section 13 was made equal to the focal distance of an objective lens 11, and distance of an objective lens 12 and a record section 13 was made into 1.5 times of the focal distance of an objective lens 12. Objective lenses 11 and 12 adjust the sense so that the optical axis of the condensed light may cross within the recording layer of an optical recording medium 16. Moreover, the difference of the optical path length of the light which penetrates an objective lens 11, and the optical path length of the light which penetrates an objective lens 12 is shorter than the coherent length of the light source.
[0065] After being condensed with an objective lens 11, an objective lens 14 is adjusted so that outgoing radiation of the light which penetrated the optical recording medium 16 may be carried out to an objective lens 11 with reinforcement and phase distribution. [**** / the light which carried out incidence] The light made into parallel light with the objective lens 14 is detected by division photodetector 15 like a CCD camera.
[0066] In addition, the parallel displacement to rotation and the direction of three dimensions is possible for an optical recording medium 16 by the driving gear 17.

[0067] On the other hand, the light by which outgoing radiation was carried out from the light source for justification (not shown) is irradiated at right angles to an optical recording medium 16, after being condensed with an objective lens 21, as shown in drawing 1 (b). The slot shall be formed in an optical recording medium 16 so that the location of the radius vector direction may be known beforehand. Although record playback light penetrates on the surface of a slot, fused silica film which reflects justification light is formed.
[0068] After the light reflected by the optical recording medium 16 penetrates an objective lens 21 to the reverse sense again, it is sent to tracking optical system and focusing optical system (not shown). The thing of arbitration can be used as tracking and focusing optical system.
[0069] The gap in the direction of three dimensions of the focal location where the justification light by which outgoing radiation was carried out from the light source for justification is condensed, and the location of the focus of record playback light shall be understood beforehand. Moreover, except the time of record, although the justification light from the light source for justification may always be irradiated by the optical recording medium 16 and you may irradiate intermittently, the light (signal light) which outgoing radiation was carried out from the light source for record playback, and penetrated the space modulator 10 shall be interrupted so that an optical recording medium 16 may not irradiate.
[0070] (Informational record) MU was recorded to the optical recording medium produced as mentioned above using the information recording device of this invention.
[0071] First, it is made for the focus of record playback light to come to the innermost part of the record section 13 of an optical recording medium 16 using a driving gear 17. Based on the tracking signal and focusing signal which used the optical system for justification and were acquired next, the location of an optical recording medium 16 is tuned finely.
[0072] the record light after adjusting the condition of the space modulator 10 so that the intensity distribution of the transmitted light according to information to record may be acquired -- a predetermined time amount exposure -- it carries out. Then, an optical recording medium 16 is rotated using a driving gear 17, and it is made for record light to be irradiated by different record section. after [then,] adjusting the condition of the space modulator 10 in the condition according to information to record on a degree -- again -- record light -- a predetermined time amount exposure -- it carries out.
[0073] Such a procedure can be repeated and data can be recorded one after another along the direction of a truck.
[0074] (Informational playback) Next, information recorded on the optical recording medium is reproduced using the above-mentioned information recording device.
[0075] First, using a driving gear 17, it adjusts so that the focus of an objective lens 12 may come to the most inner circumference of the recording layer of an optical recording medium 16. Based on the tracking signal and focusing signal which were acquired using the optical system for justification, the location of an optical recording medium is tuned finely. Next, the light which penetrates an objective lens 12 is irradiated at an optical recording medium 16, and the location of the direction of a truck is adjusted. Adjustment of the location of the direction of a truck can check that playback light has connected the focus to the right location by technique which is performed by reference "Implementation of Holographic Optical Disc" (15 Proceeding of the International Symposium on Optical Memory, pp14- 1998). When playback light is irradiated, the aperture is prepared out of the field where information is reproduced and a pit specifically reaches this aperture, it means that playback light had connected the focus to the right location. By measuring that by which playback light was diffracted with the divided photodetectors 15, such as CD, information is reproducible with a high SN ratio.
[0076] Precision is improved by the alignment of record playback light when the optical axis of the light condensed with objective lenses 11 and 12 is parallel to the direction of a truck, as already especially explained with reference to drawing 2 .
[0077] Moreover, precision is improved by the alignment of record playback light when it is the wavelength from which the wavelength of justification light is a hologram record front and after record, and the refractive index of an optical recording medium does not change, as explained with reference to drawing 3 .

[0078] Furthermore, in the information recording device of this invention, the light from the light source for record is divided into two, signal light and a reference beam, and, as for these signal light and reference beams, it is desirable that incidence is carried out to a Motomitsu Mitsugi record medium by the incident angle which does not produce primary interference. When the line which connected the core of objective lenses 11 and 12 and the core of a record section 13 specifically sets the front face of the Motomitsu Mitsugi record medium 16, and the angle to make to theta1 and theta2, respectively, it is desirable to fulfill the conditions explained below. If this condition is fulfilled, it is possible to make still smaller the noise at the time of acquiring a tracking signal and a focusing signal.
[0079] However, wavelength of the light by which outgoing radiation is carried out in the refractive index of a recording layer from the light source for n and record playback and the light source for justification is set to lambda1 and lambda2, respectively. This is explained with reference to drawing 6 .
[0080] Although laser light is condensed at the time of hologram record and an optical recording medium is irradiated, below is asked for the conditions from which justification light does not receive diffraction even if a hologram is recorded noting that the parallel light which passes along an optical axis is irradiated, since it is easy.
[0081] The light from the light source for record is divided into two, signal light and a reference beam, and an interference fringe is formed by irradiating a Motomitsu Mitsugi record medium and making these two light cross inside. Here, when the incident angle of the signal light measured on the outside of an optical recording medium is theta 1, it asks from nsintheta1 inch=sin theta 1 incident angle theta1inch measured inside the optical recording medium. The incident angle measured inside the record medium is similarly searched for from nsintheta2 inch=sin theta 2 from a reference beam. At this time, the wave number vector of the interference fringe formed is called for with the following formula (1).
[0082]
[Equation 1]

$$\vec{k} = \overrightarrow{k_1} - \overrightarrow{k_2} = \frac{2\pi}{\lambda 1 / n}\begin{pmatrix} \sin\theta 1^{in} - \sin\theta 2^{in} \\ 0 \\ \cos\theta 1^{in} - \cos\theta 2^{in} \end{pmatrix}$$

[0083] When justification light is perpendicularly irradiated by such interference fringe, it is a time of theta 0 which fills the following formula (2) existing that diffraction arises most strongly.
[0084]
[Equation 2]

$$\frac{\Lambda}{\sin\theta K} + \frac{\Lambda}{\sin\theta 0} = \lambda 2 / n$$

[0085] Therefore, the conditions in which the direction where justification light is diffracted strongly does not exist are expressed with the following formula (3).
[0086]
[Equation 3]

$$\frac{1}{\sin\theta 0} = \frac{\lambda 2 / n}{\Lambda} - \frac{1}{\sin\theta K}$$

$$= \left(\frac{\lambda 2}{\lambda 1} - \frac{1}{\cos\theta 2^{in} - \cos\theta 1^{in}}\right) * \sqrt{2 - 2\cos(\theta 2^{in} - \theta 1^{in})} < 1$$

[0087] Since justification light does not receive interference even if a hologram is recorded by fulfilling such conditions, it becomes possible to reduce further the noise at the time of acquiring a tracking signal and a focusing signal.
[0088] In addition, this invention is not limited to the operation gestalt mentioned above. For example, as justification light penetrates the inside of a medium, when it detects the transmitted light, you may justify. In addition, it can carry out by deforming variously in the range which does not deviate from the meaning of this invention.

[0089]
[Effect of the Invention] The information recording device which is an information recording device which records information on the Motomitsu Mitsugi record medium with which information is recorded as a hologram according to this invention as explained in full detail above, and can realize the tracking and focusing of record light with a sufficient precision is offered. By using the information recording apparatus of this invention, the SN ratio of data playback of a three-dimensional-record medium can be improved remarkably, and the industrial value is greatest.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram showing the configuration of an example of the information recording device concerning this invention.
[Drawing 2] The schematic diagram explaining the relation of the direction of the slot on concavo-convex and the direction of radiation of record light which were formed in the reflecting layer.
[Drawing 3] The graphical representation which expressed change of the absorption coefficient of an optical recording medium, and a refractive index as a function of wavelength.
[Drawing 4] The schematic diagram showing the configuration of other examples of the information recording device concerning this invention.
[Drawing 5] The schematic diagram showing the configuration of the Motomitsu Mitsugi record medium produced in the example.
[Drawing 6] The schematic diagram explaining the interference fringe formed of signal light and a reference beam.
[Description of Notations]
10 -- Space modulator
11 12 -- Condensing means (lens)
13 -- Hologram record section
14 -- Objective lens
15 -- Detector
16 -- Motomitsu Mitsugi record medium
17 -- Driving gear
21 -- Condensing means (lens)
31 -- Irregular reflective film
32 -- Glass substrate
33 -- ITO film
34 -- Spacer
35 -- ITO film
36 -- Glass substrate
37 -- Recording layer
38 -- Spacer
100 -- Motomitsu Mitsugi record medium (disk)
101 -- Signal light
102 -- Reference beam
103 -- Protective layer
104 -- Recording layer
105 -- Reflecting layer
106 -- Justification light
107 -- Interference fringe

108 -- Hand of cut of a medium
110 -- The light source of record light
111 -- A means to divide record light
112 -- A means to give spatial reinforcement and phase modulation to record light
113 -- Mirror
114,115 -- A means to condense record light
116 -- The light source of justification light
117 -- A means to divide justification light
118 -- Quarter-wave length plate
119 -- A means to condense justification light

[Translation done.]

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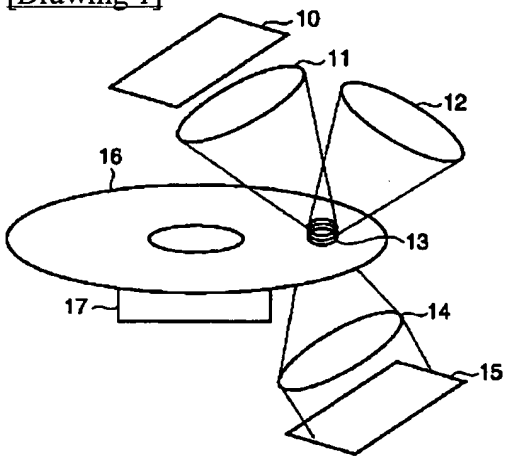
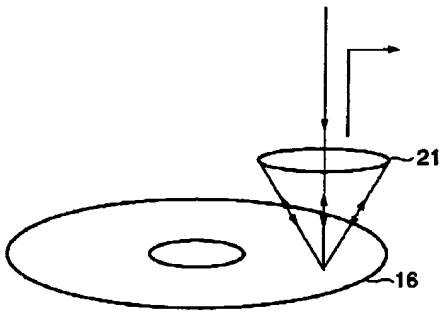
DRAWINGS

[Drawing 1]



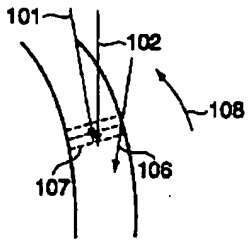
(a)



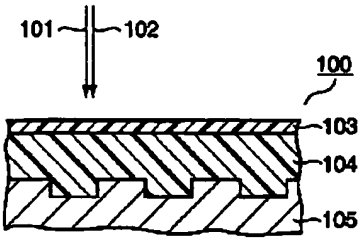
(b)

[Drawing 2]

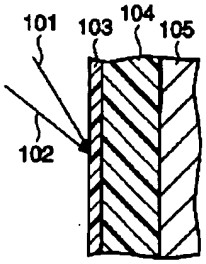
(a)



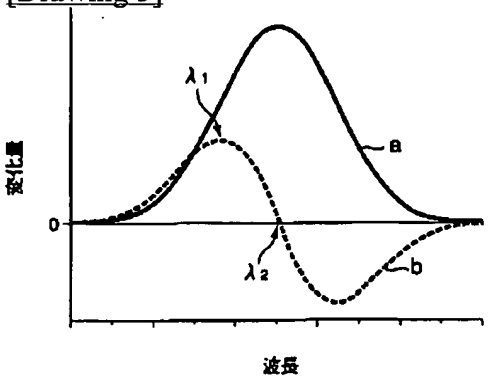
(b)



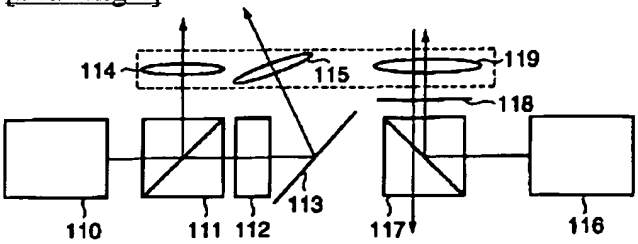
(c)



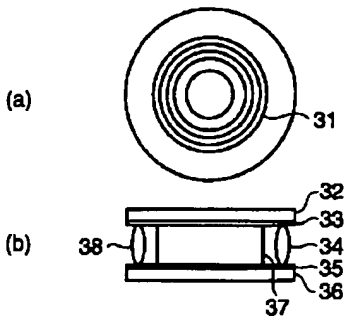
[Drawing 3]



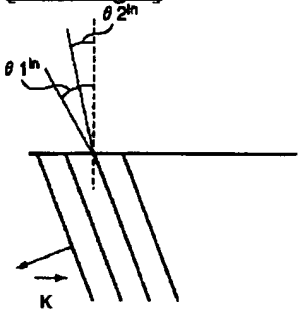
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]